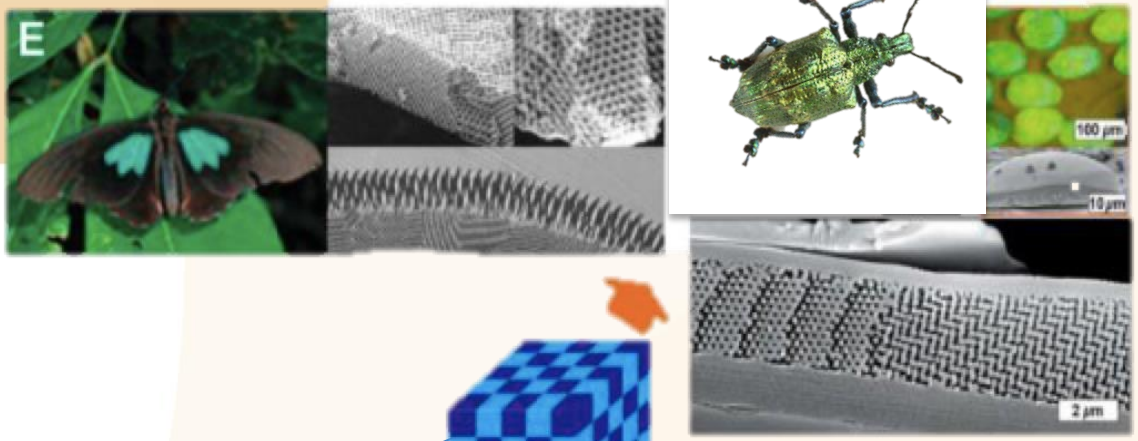
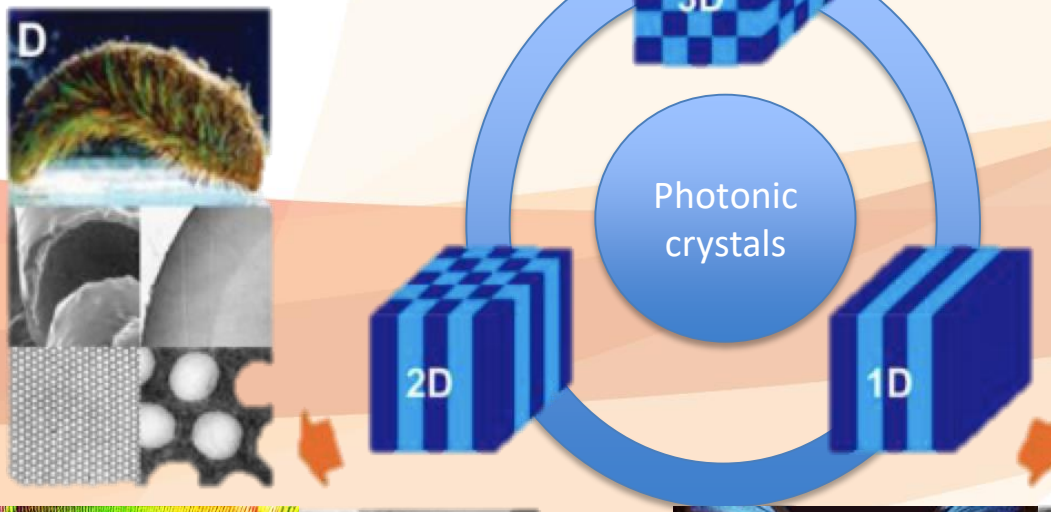
Porto, 13 de fevereiro de 2017

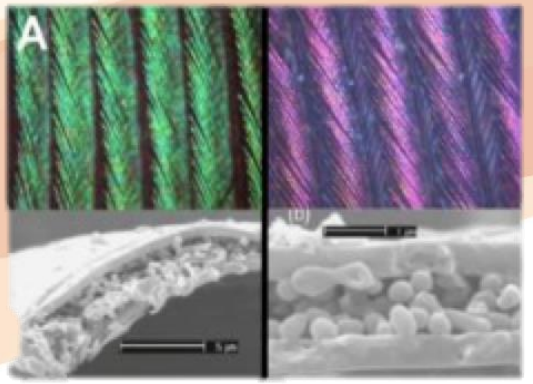
Structural Coloration in Textiles

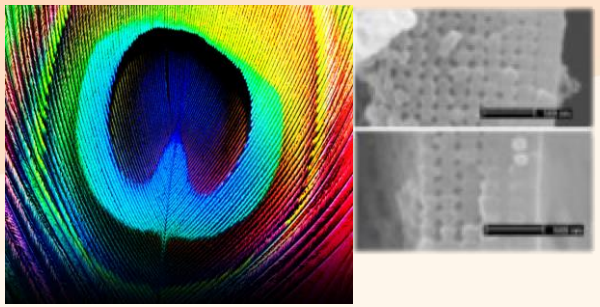
António Pedro Souto, Andrea Zille
Departamento de Engenharia Têxtil
Universidade do Minho Portugal
souto@det.uminho.pt

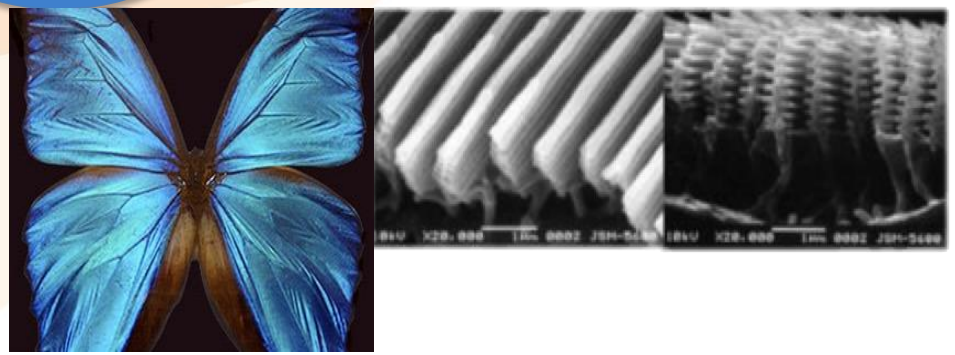
Gonul Yavuz
Ege University Textile and
Apparel Research and Application Center
İzmir, Turkey







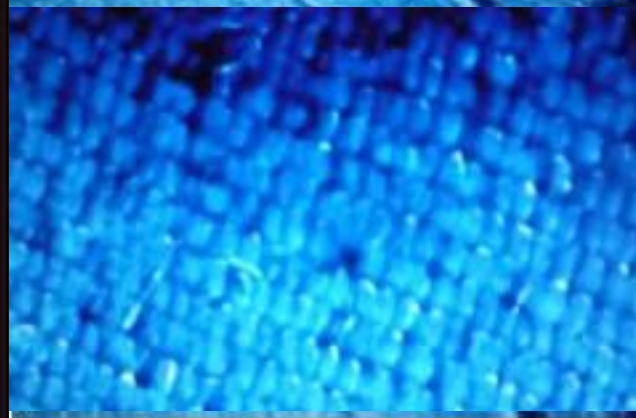
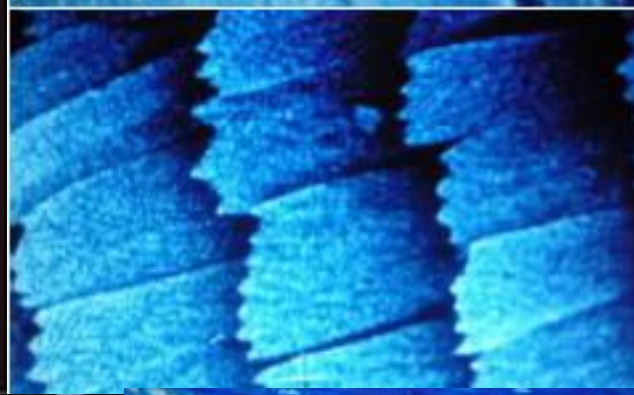




doi:10.3390/s130404192

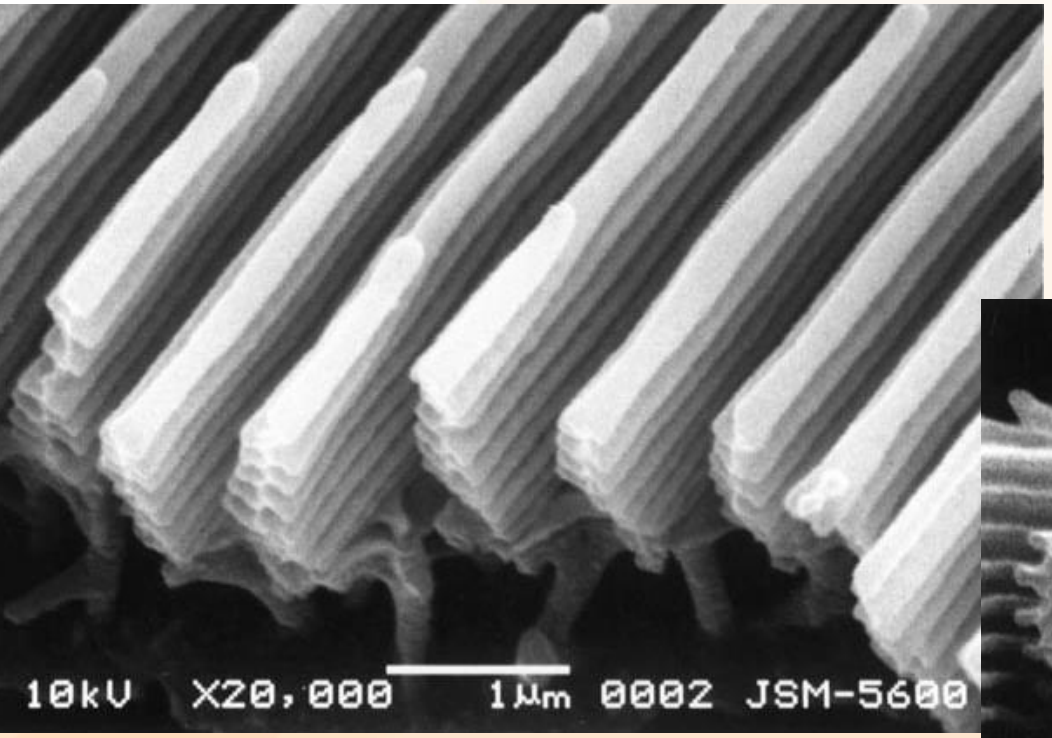
Photonic Crystals 1D
Morpho butterfly

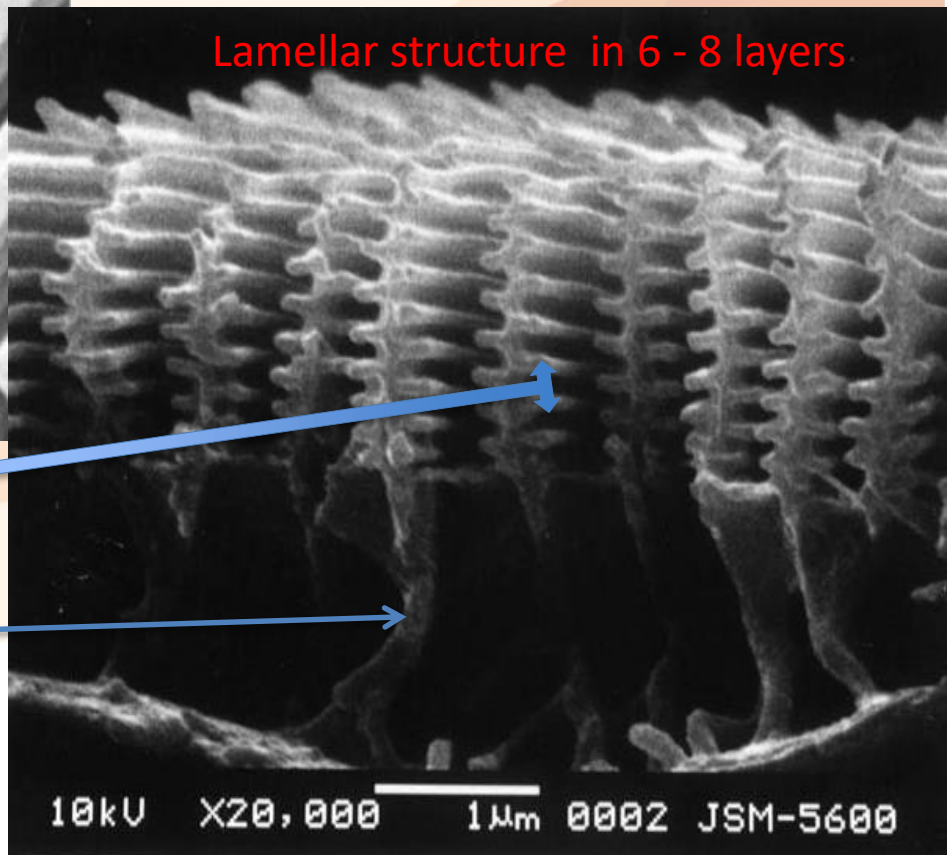




Photonic Crystals 1D Morpho butterfly



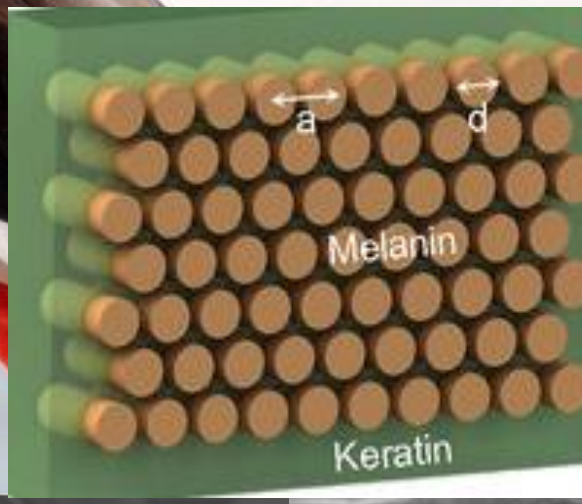


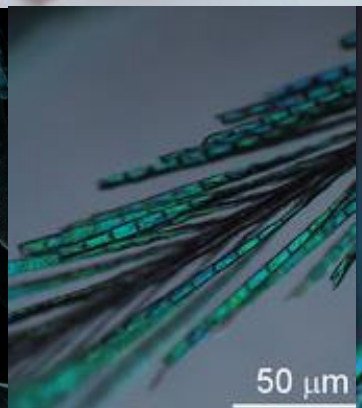
doi: 10.1098/rspb.2002.2019

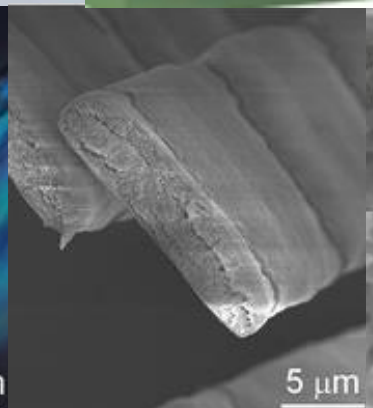
200 nm

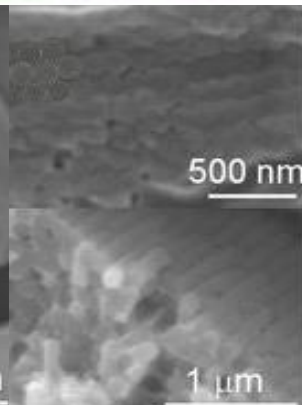
The pigmentation in the scale absorbs the extraneous green to red light and enhances the blue colouring

Photonic Crystals 2D
Mallard duck

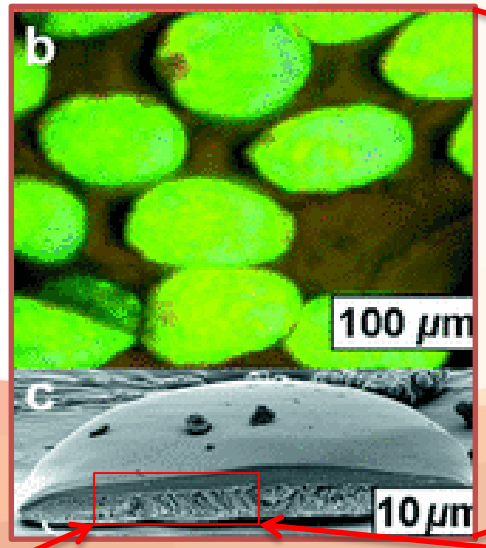


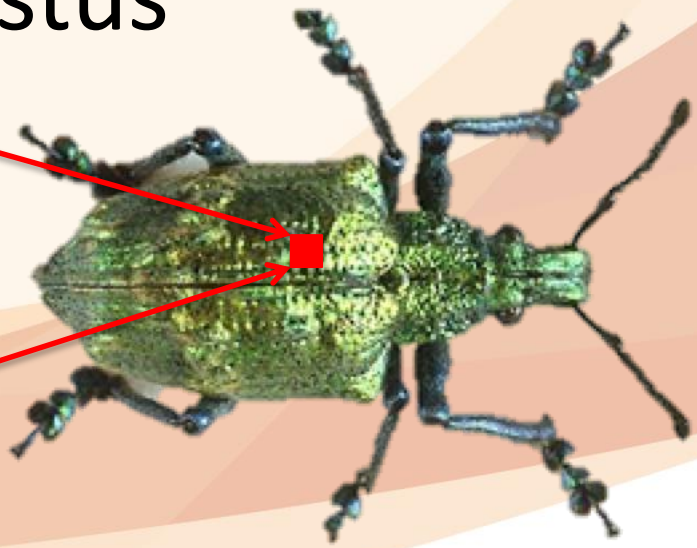




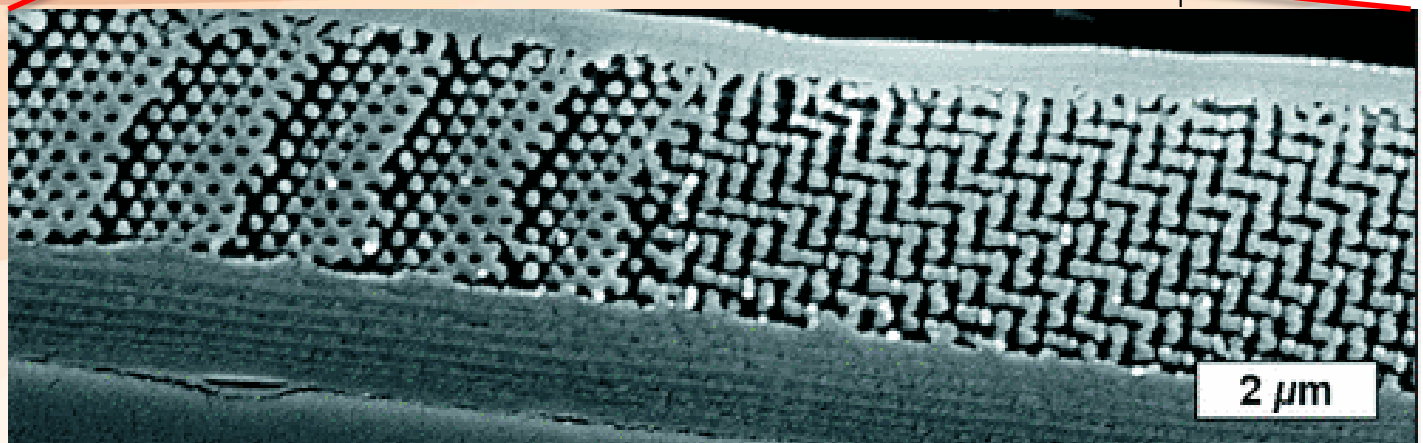


Photonic Crystals 3D diamond-based structure in the beetle L. augustus

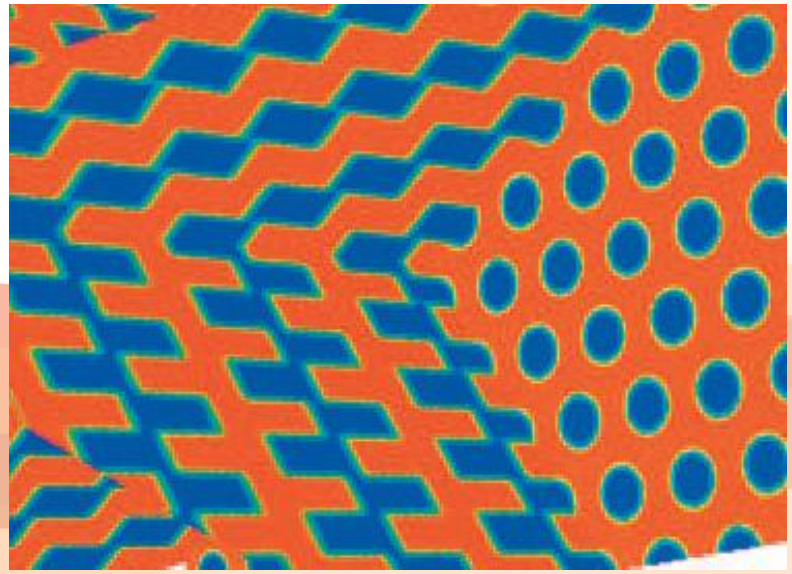


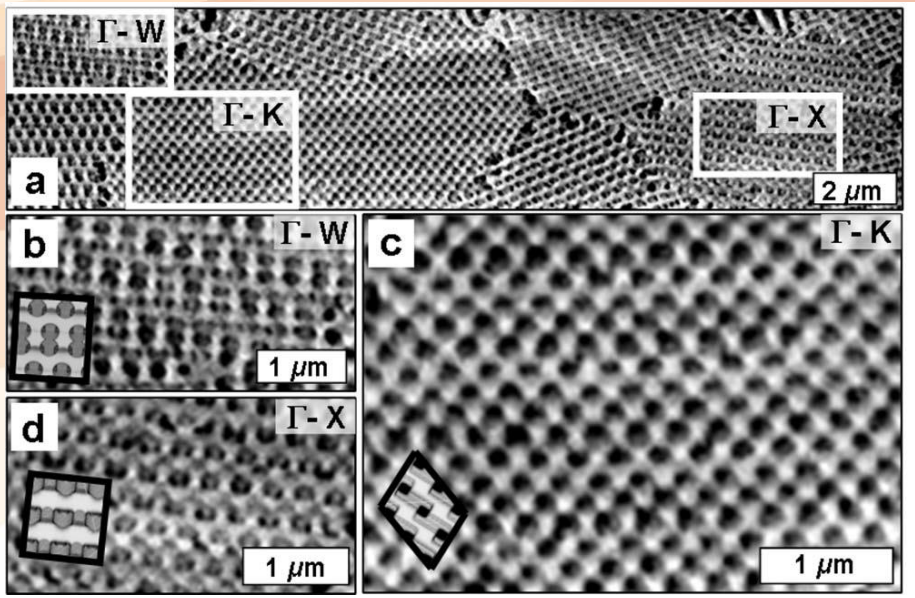


http://physicsbuzz.physicscentral.com/2008_05_01_archive.htm



Photonic Crystals 3D diamond-based structure in the beetle L. augustus



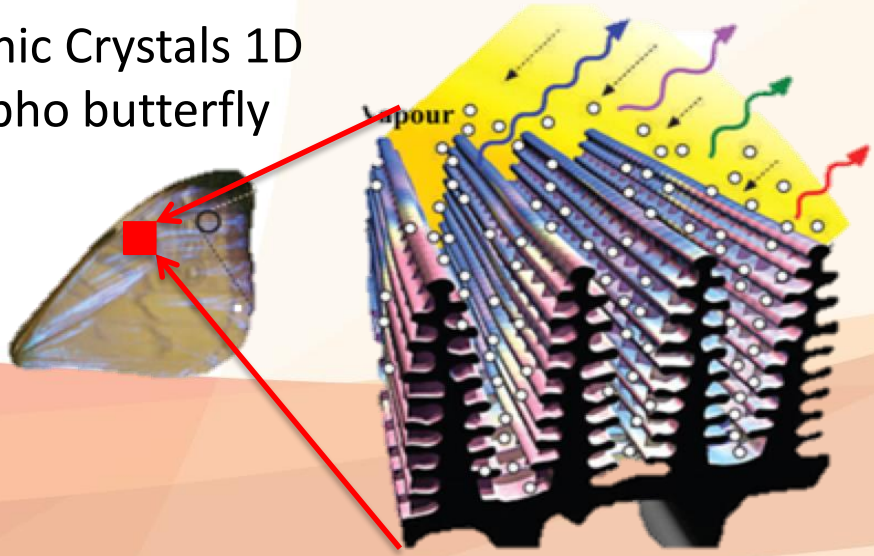


http://physicsbuzz.physicscentral.com/2008_05_01_archive.html

Sensors made of Photonic crystals

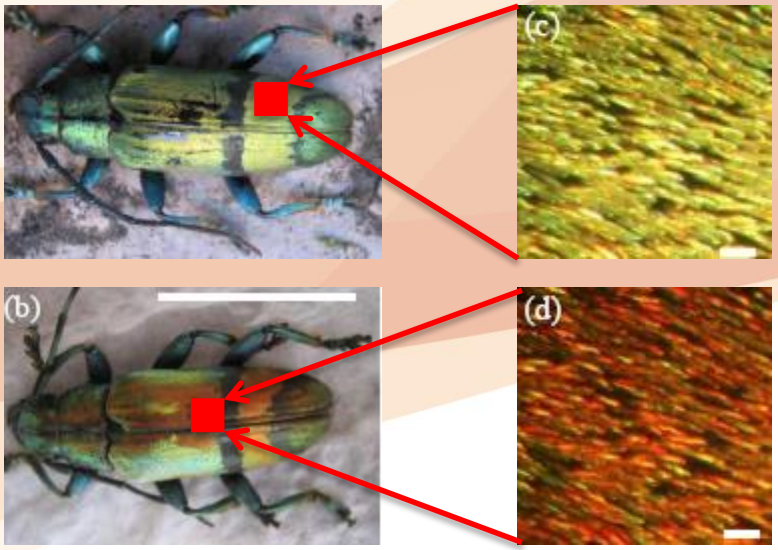
- by humidity effect

Photonic Crystals 1D
Morpho butterfly



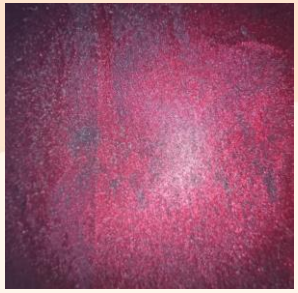
http://cdn.iopscience.com/images/0957-4484/27/12/122001/Full/nanoaa13e1f8_lr.jpg

Photonic Crystals 3D
beetle Tmesisternus isabellae

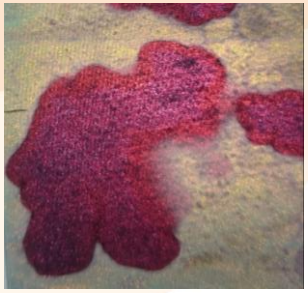


F. Liu, B. Q. Dong, X. H. Liu, Y. M. Zheng, J. Zi, "Structural color change in longhorn beetles Tmesisternus isabellae," Opt. Express **17,** 16183-16191 (2009);
https://www.osapublishing.org/oe/abstract.cfm?uri=oe-17-18-16183

- at our lab:



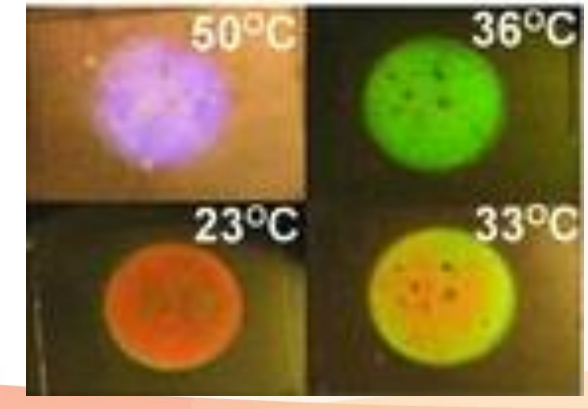
- wet



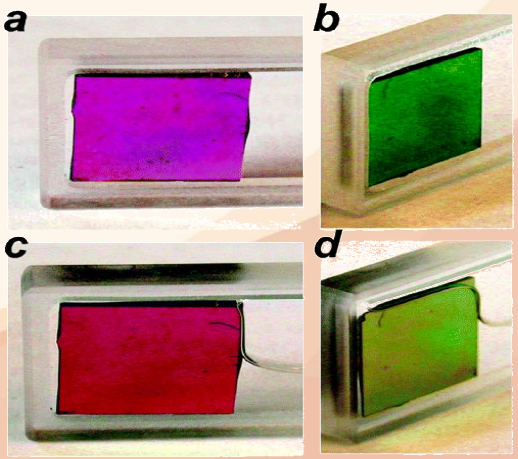
- drying

Sensors made of Photonic crystals

- by temperature effect



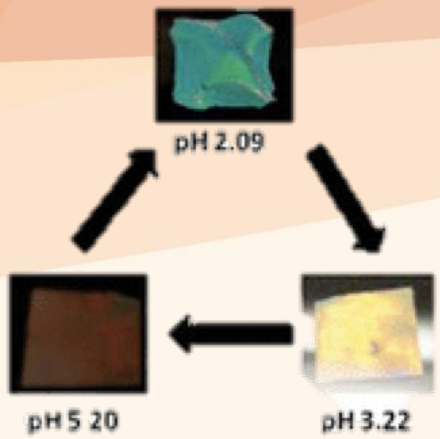
- by chemical effect



In air

In ethanol

- by pH effect



- others:
  - .ionic species
  - .pressure
  - .biomolecules

doi:10.3390/s130404192 **DOI:** 10.1021/nl061580m **DOI:** 10.1002/adma.201202459

Lab preparation
“soap-free emulsion polymerization”

Monodispersed composite latex spheres of poly-(styrene-methyl methacrylate-acrylic acid) (P(St-MMA-AA)) were synthesized by soap-free emulsion polymerization in a three-necked flask equipped with a reflux condenser and a mechanical stirrer.

The mixture was stirred at 70 °C in N_2 atmosphere for 5 h to obtain a homogeneous particle diameter of ~380 nm.

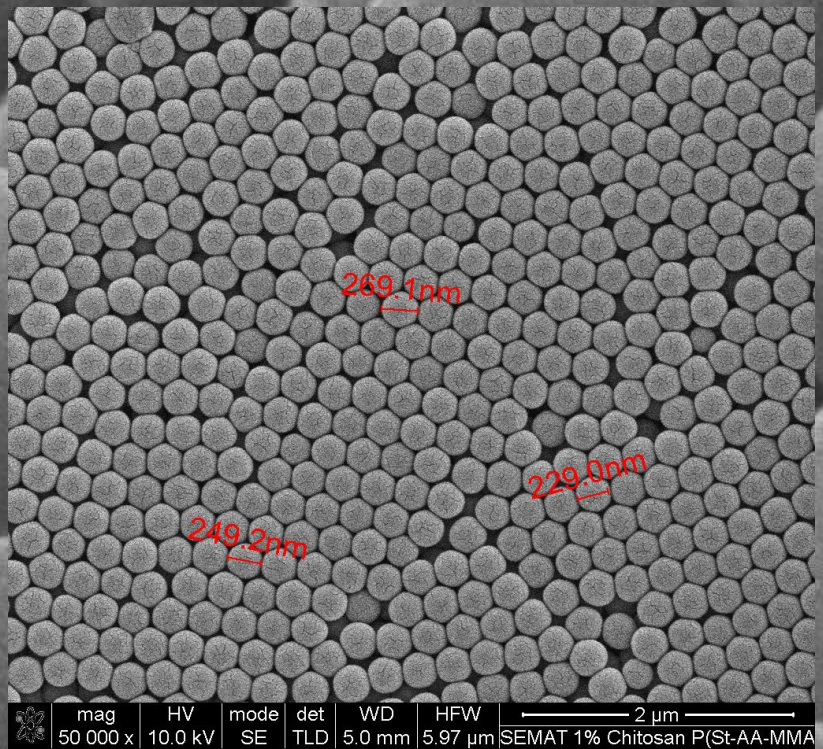
Nanophotonic Crystals Size Control parameters

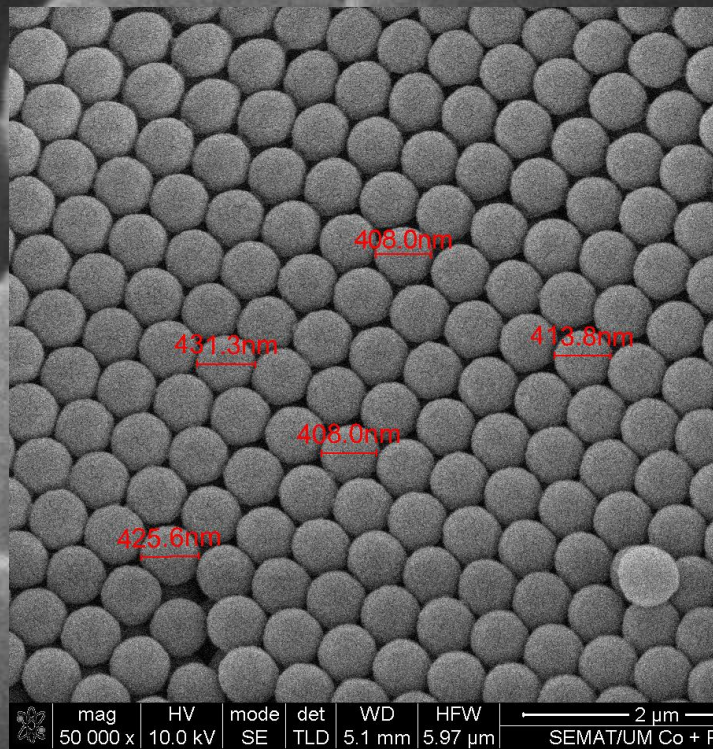
To make larger spheres:

a. use a bigger concentration of monomer,

b. use a lower temperature, or

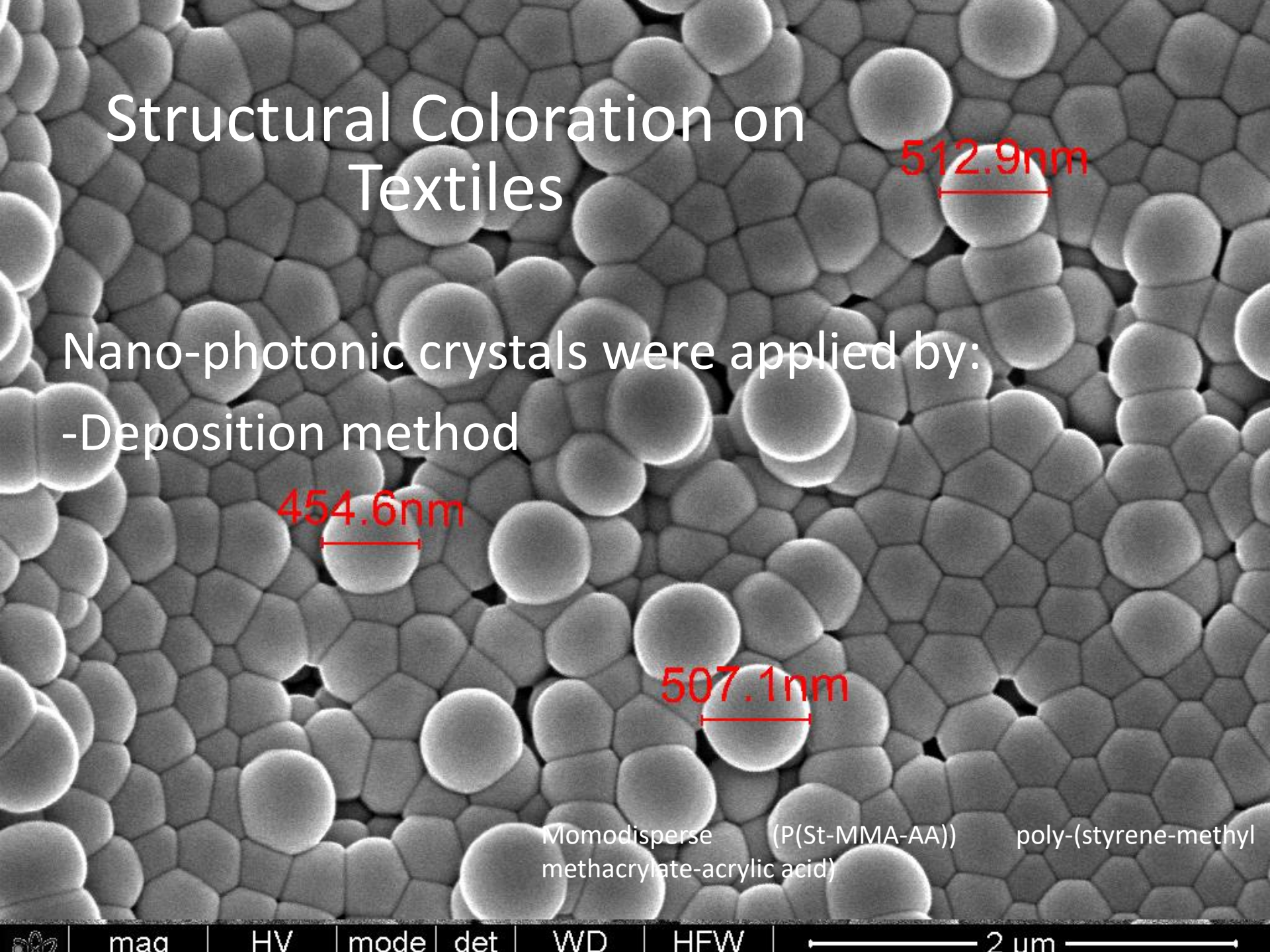
c. use less initiator.





281.2nm

Structural Coloration on Textiles

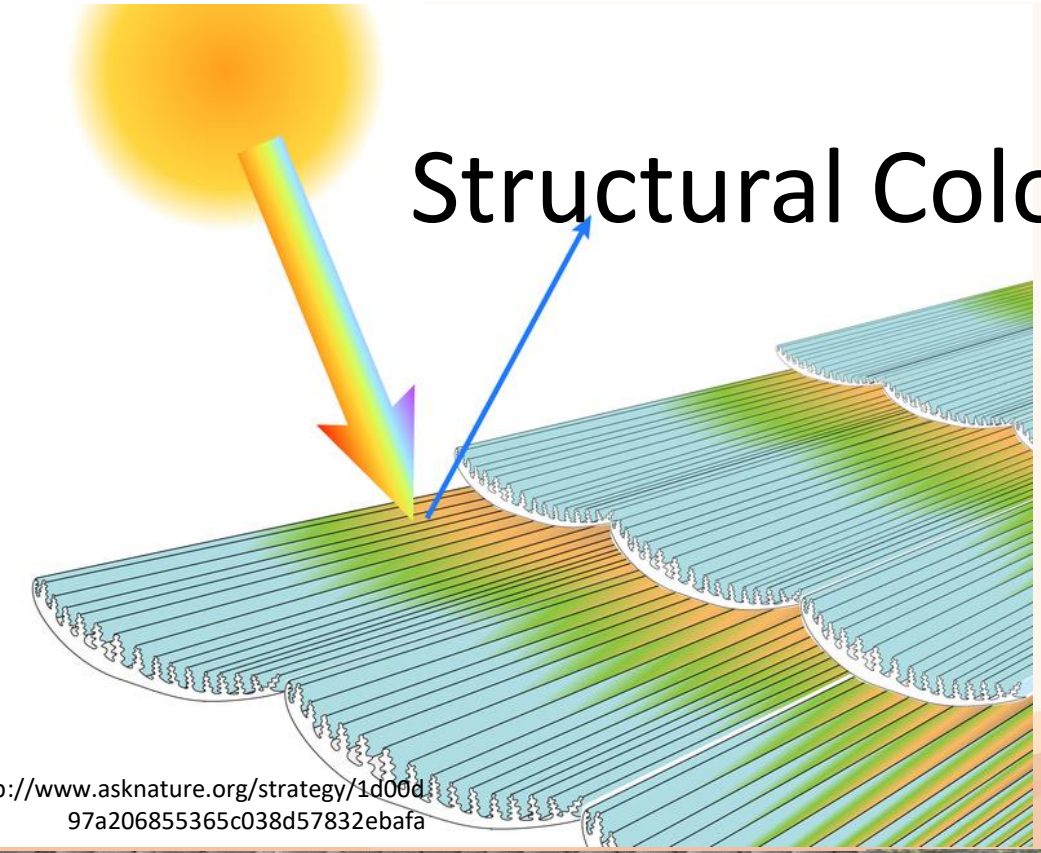


Nano-photonic crystals were applied by:

-Deposition method

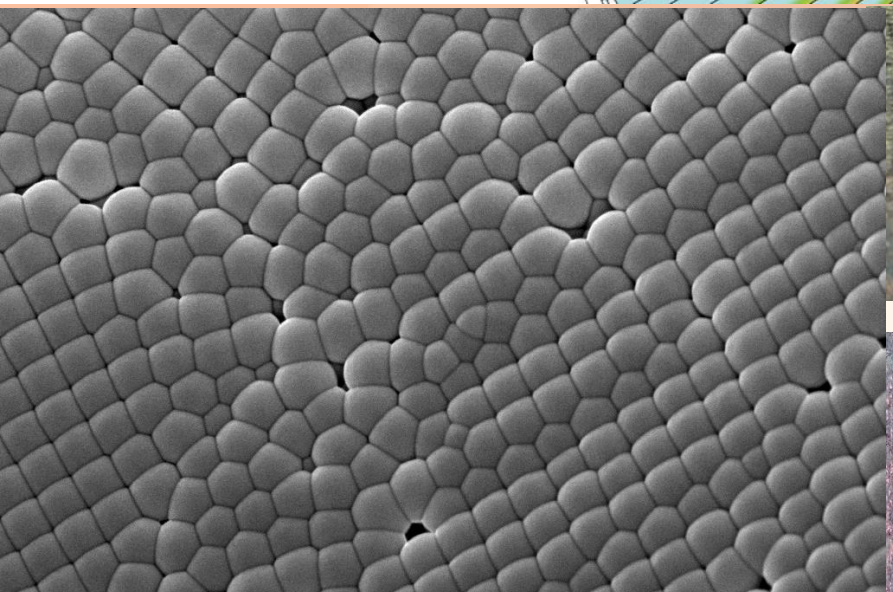
Momodisperse (P(St-MMA-AA)) poly-(styrene-methyl methacrylate-acrylic acid)

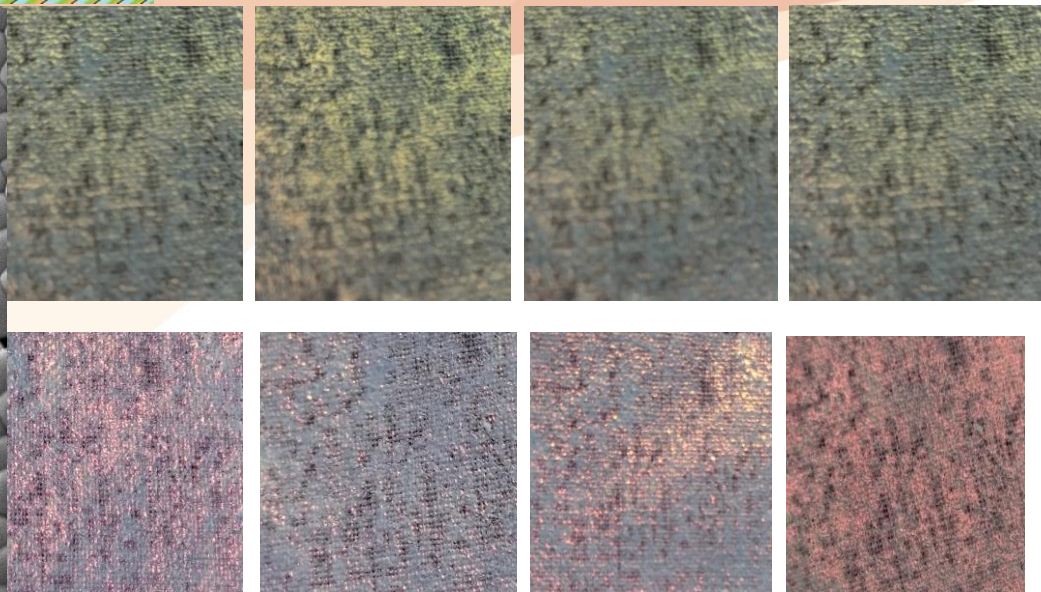
Structural Coloration on Textiles



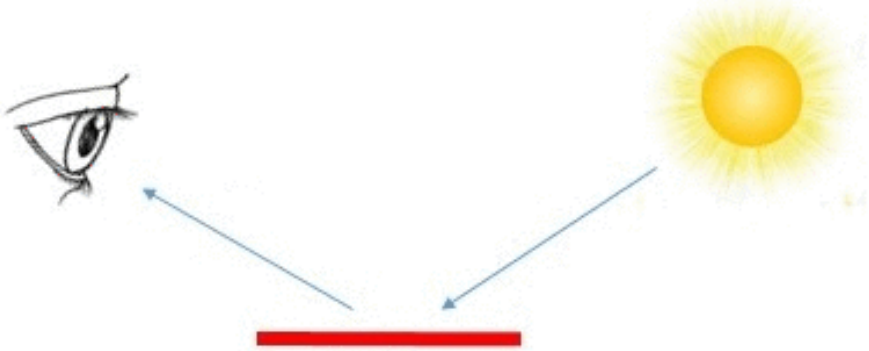
p://www.asknature.org/strategy/1d00d97a206855365c038d57832ebafa

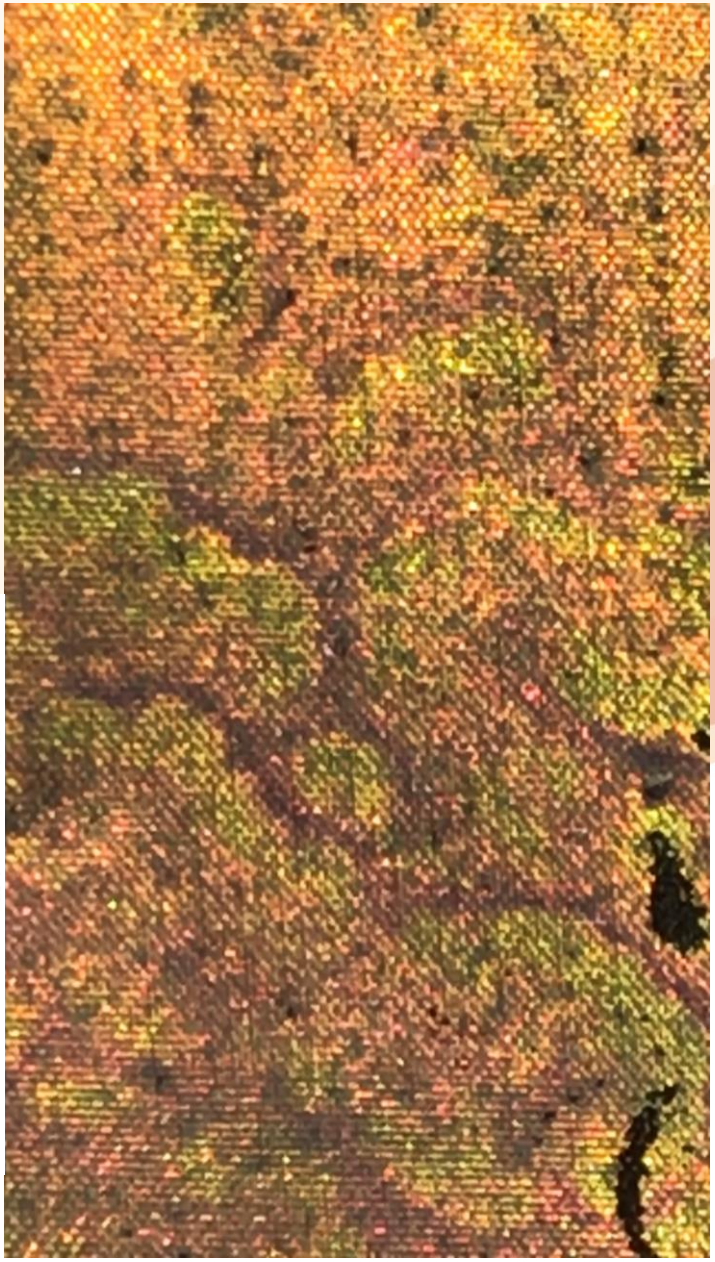
Color without pigment/dyes on fabric, by applying a coating with nanophotonic crystals





Structural Coloration on Textiles

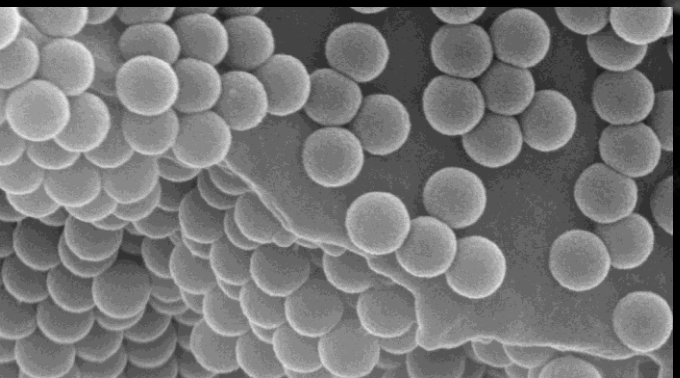




Applying Nano-photonics Crystals to Textile

- How to improve washing durability?

A study is going on to improve washing fastness, without loosing the handle properties, applying mixture of polymers.



Nowadays challenges

- Can we give to the Nanophotonic crystals colour?

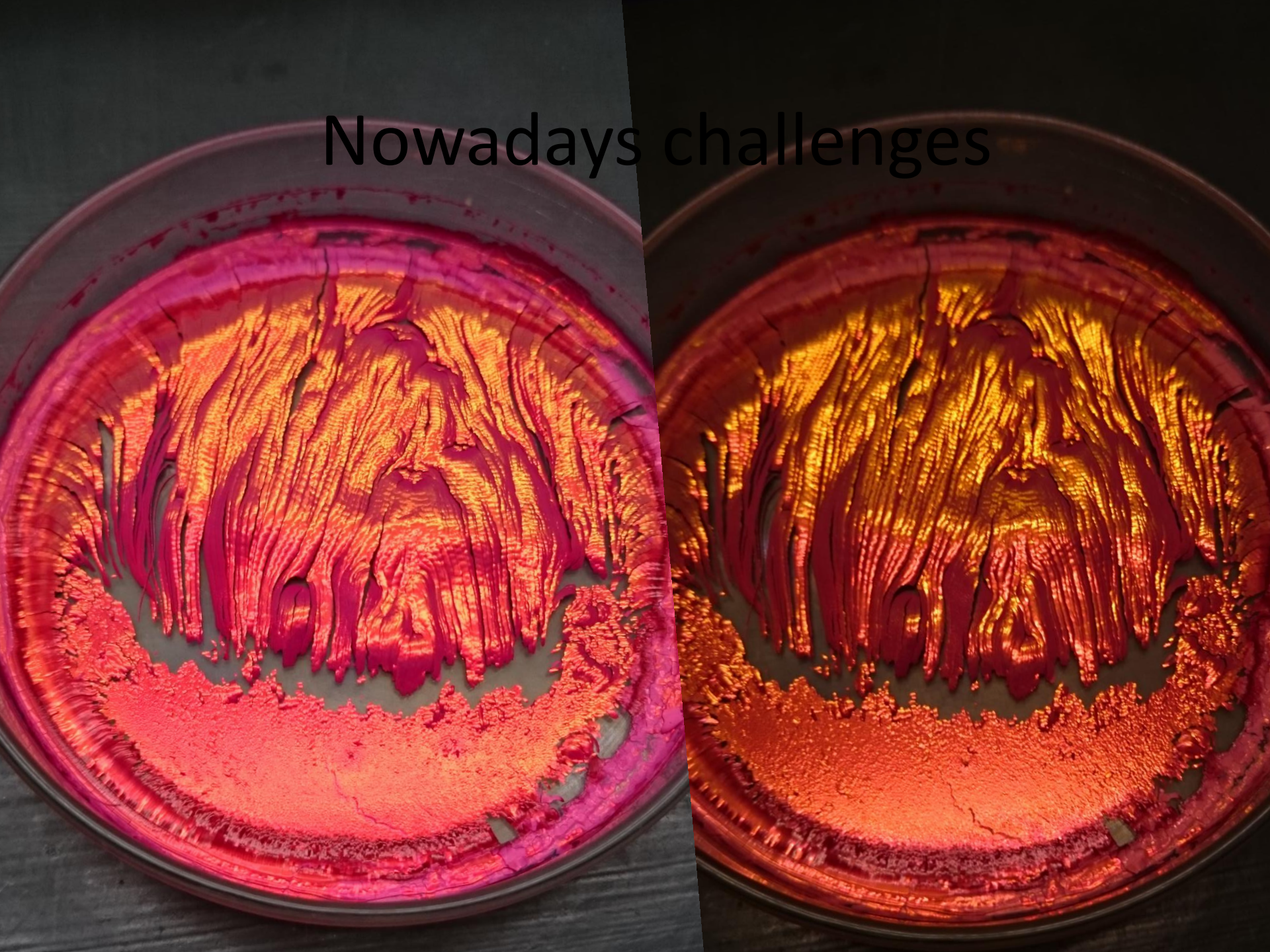
  YES, WE CAN -> We have done it!

- Can we “work” with several layers of color?

  YES, WE CAN

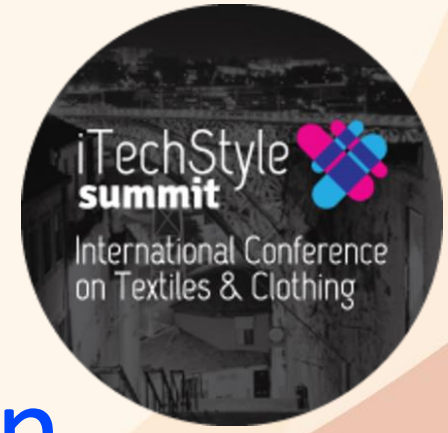
Nowadays challenges

Nowadays challenges



Conclusion

1. It is possible to obtain color using nanophotonic crystals
2. Nanophotonic crystals can be applied to textiles
3. It is possible to increase washing fastness of these colorful systems
4. Structural coloring is an innovative and ecological technology, which can reduce the environmental impact of traditional coloring processes.



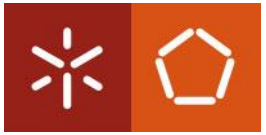
Thank you for your attention

The authors would like to express their acknowledgment to the organizers of:

iTechStylesummit

International Conference on Textiles & Clothing

António Pedro Garcia de Valadares Souto
Universidade do Minho, Guimarães / Portugal
Departamento de Engenharia Têxtil
souto@det.uminho.pt



Dep. Engenharia Têxtil